Lessons for Transforming Logistics

The new wing structure consists of four groups: the operations group, maintenance group, mission support group, and medical group. Transformation is likely to continue, and organizations will likely continue to evolve to support changing mission requirements within current resource constraints.

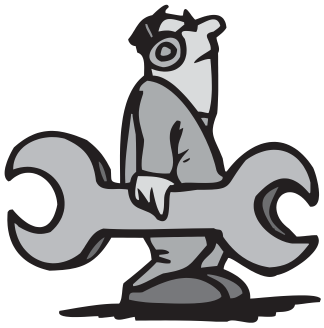
logistics history

Maintenance Organization: A Historical Perspective

As the Air Force has evolved, many factors have come into play with respect to the organization of aircraft maintenance functions—technology (to include systems and systems reliability and maintainability), budgetary constraints, spares availability, manpower availability, and training. From a historical perspective, in response to these factors, two trends can be seen—alternating centralized decentralized operations and moving between standardized and MAJCOM-driven maintenance organizations. As a backdrop for transformation and lessons to be learned, "Maintenance Organization: A Historical Perspective" reviews the evolution of the Air Force maintenance organization.

Lessons for Transforming Logistics | David George, Kristen F. Lynch
Robert S. Tripp, and John G. Drew

A historical perspective
Maintenance Organization



The rapid growth of aviation during World War I increased the need for airplane mechanics and engineering officers.

Over the years, many factors have affected the way aircraft maintenance has been organized, including training requirements, technician skill levels, availability of personnel (manning levels), availability of spares, budgetary constraints, and technical systems reliability and maintainability. Historically, training requirements have increased as aircraft complexity has increased. As the manpower levels were decreased, generalist training was resumed—but only until aircraft complexity drove the need for greater specialization.

Maintenance Organization During the Early 1900s

World War I, Decentralized Maintenance

Prior to 1917, the flying squadron had evolved as the established tactical unit. The squadron commander was responsible for upkeep and repair of all airplanes and equipment under his command. Aviation mechanics, enlisted men of any grade, were appointed after testing. There was a basic company and section formation; officers were pilots who were also in charge of section maintenance. Aircraft were technologically unsophisticated, and enlisted personnel were experts on the entire aircraft.

After World War I, when Major General Mason M. Patrick became chief of the Air Service, he issued Memorandum No 37, which established the Air Service plan for the supply, salvage, and repair of airplanes. The effect of this memorandum was to establish echelons of maintenance, which would be the accepted structure and the basis for different repair levels and locations for many years. The plan called for a network of groups, mobile parks, air depots, intermediate depots, depots, acceptance fields, and production centers. The first echelon cited in the memorandum was the group, made up of squadrons, which performed aircraft and engine maintenance repairs at the local level. The group was designed to be a self-contained unit, not constrained with heavy equipment that would hinder its mobility.[1]

The rapid growth of aviation during World War I increased the need for airplane mechanics and engineering officers. By 1918, the aero squadron was established. The aero squadron consisted of four sections: headquarters, engineering, supply, and flying. Maintenance was within the engineering section. For airplanes, a repair crew—consisting of a crew chief, an assistant crew chief, and various mechanics—was established. The crew chief was the individual responsible for all servicing and repair of the aircraft. Soon after entry into World War I, maintenance organizations at flying fields could not handle overhauls and complicated repairs, so maintenance depots were established, centralizing some repair. The depots were located in Dallas, Texas; Montgomery, Alabama; and Indianapolis, Indiana.[2]

During the 1920s, as equipment advanced, maintenance at the squadron level improved with the introduction of aircraft record keeping (such as aircraft condition record, record of receipt of the airplane, and daily airplane crew report). The introduction of instruments, cameras, radios, and armament—still relatively simple machines—

Aircraft complexity has driven the need for maintenance specialization and caused aircraft maintenance to be reorganized many times since the 1900s.

brought about the first major specializations. Training of airplane mechanics was still very broad. The mechanic was qualified in all systems except armament, camera, and radio. This generalist training led to the establishment of a crew chief system of maintenance. The crew chief became a second-term master mechanic and a graduate of Chanute Field, Illinois, master mechanics courses. The crew chief and his crew members maintained the airframe, engines, controls, and accessory systems. The specialist who was not assigned to the crew maintained armament, cameras, and radios. The specialists were assigned to a service squadron or company, usually collocated on the flying field, and performed maintenance beyond the capability of the crew chief and his crew.[3]

World War II, Centralized Maintenance

By 1939, the Army Air Service was still relatively small, with an inventory of fewer than 2,000 aircraft. The Air Service's Engineering Division at McCook Field, Ohio, was combined with the Supply Division and the Industrial War Plans Division and moved to Wright Field, Ohio. This new organization was titled the Materiel Division. It was responsible, in part, for establishing maintenance criteria, policies, and procedures and for exercising authority over all maintenance performed at flying units throughout the continental United States (CONUS).[4]

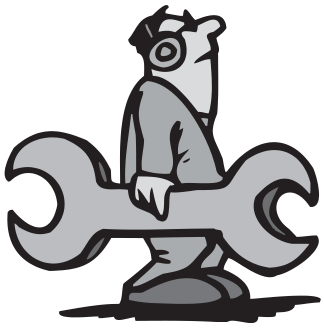
Using the cumulative experience of World War I and the postwar period, the newly named Army Air Corps gradually evolved into a new version of the echelon maintenance system. First echelon maintenance was work accomplished by the crew chief of the basic combat unit and included pre- and postflight inspections and minor repairs and servicing. Second echelon maintenance was accomplished by the crew chief with assistance from service squadron shops and included periodic inspections, adjustments or replacement of equipment, and engine changes. Third and fourth echelon maintenance was done at subdepots and depots.[5]

The first significant effects of technology on maintenance were seen with the adoption of metal tubing and pressed metal construction. These materials required a new class of skilled mechanics to handle the welding and riveting operations. The all-metal aircraft had controls, armament, and even landing gears that were tucked away out of the slip stream to increase speed, range, and performance. Accessibility decreased, making maintenance on these systems more difficult. One other significant change concerned the method of determining aircraft overhaul. The old method of the engineering officer's determining when the aircraft required depot overhaul finally evolved to the 1939 policy of using flying hours as the criterion.

World War II led to enormous growth in the Army Air Corps. In maintenance, flight chiefs and line chiefs became maintenance officers overnight; apprentice mechanics became line chiefs. The demand for mechanics exceeded the supply. The course length at Chanute was reduced to get mechanics into the field sooner. The broadened crew chief training was replaced by shorter, specialized training, producing the modified crew chief system. The new system included a crew chief with a crew of airplane general and engine mechanics who were responsible for flight-line and periodic maintenance. A pool of specialists was located within the squadron to aid the ground crew. The large number of people involved in aircraft maintenance drove the need for a structured maintenance organization in the combat group to replace the previous year's approach of operating under each flying squadron.

During this era, overseas theater commanders were allowed to modify or even ignore the maintenance organization structure that was mandatory in CONUS.[6] These overseas units were varied and adapted to local situations. The maintenance situation overseas was one of hard, long hours, but the outlook was generally bright, with rapid promotions, excellent parts availability, development of excellent skills, and units of high-capacity and high-quality maintenance.

Overseas operations contrasted starkly with stateside conditions, where aircraft were limited and often war-weary assets brought back from overseas, supplies were limited, and maintenance personnel were often inexperienced trainees. The stateside requirement was still one of vast amounts of flying time to train combat crews and constant recycling of trainees. These conditions prompted a high degree of specialization; teams and functional groupings of maintenance personnel were established in a dock system where hangar crews accomplished scheduled inspections in accordance with jobs that were sequenced. For each task, people were trained solely against that task. Workflow through the dock was carefully scheduled, and postdock maintenance was developed to clean up carryover work. Engine buildup went through the same high degree of specialization. The result, organizationally, was a mandated, highly structured organization to manage these specialized assets.



Prior to the National Defense Act of 1947, which established a separate Air Force, maintenance organizations had many top-level maintainers but few skilled mechanics.

A combat group had a commander for all group maintenance, which was done in a maintenance section headed by an engineering officer. The section was divided into two branches: a flying line maintenance branch and a production line maintenance branch, each headed by an assistant engineering officer. The flying line maintenance branch was broken into four units: one each for maintenance, servicing, armament, and communications. This branch was responsible for servicing, preflight, daily and 25-hour inspections, filling out forms, all contact with aircrews, replacement of aircraft and engine units (unless it would involve excessive out-of-commission time), and accomplishment of technical order changes.

The production line maintenance branch consisted of 14 units: one each for cockpit and cabin, cleaning, flight controls and surfaces, hydraulic and landing gear, engine, fuel and oil, electrical, instrument, propeller, armament, communications, metal repair, ground equipment repair, and parachute. This branch was responsible for washing and cleaning; accomplishment of 50-hour, 100-hour, and other periodic inspections; engine changes; and technical order changes beyond the capability of the flying line maintenance branch. The production branch also changed major assemblies; did metal repair and maintenance and servicing of flight-line and hangar equipment; and prepared engines and aircraft for return to supply or depot and aircraft for return to depot.[7]

Post-World War II, Decentralized Maintenance with Centralized Control

After World War II, regulations began to be used to define maintenance organizations. These regulations reflected both previous experience and the changes brought about by differences in technology, personnel availability, and mission requirements. In August 1945, the US Army Strategic Air Forces published Regulation 65-1, *Combat Maintenance Procedures.*[8] This publication established a decentralized maintenance section with strong centralized control in the form of wing maintenance control. It also provided for a combat maintenance officer and specialized maintenance organizations, including flight-line maintenance, scheduled maintenance, engine buildup, and servicing. This regulation set the stage for postwar maintenance organizations and procedures.

Prior to the National Defense Act of 1947, which established a separate Air Force, maintenance organizations had many top-level maintainers but few skilled mechanics. A huge postwar loss of skilled mechanics, no strong enforcement of any maintenance system, and the introduction of new jet-powered aircraft in the form of the Lockheed P-80 led to these conditions. Prior to establishment of the new service, Army Air Forces Regulation 65-1, *Supply and Maintenance Program of the Army Air Forces*, was released as a revision to the former 65-1. This revision did little other than to call out the new terminology (organizational, field, and depot maintenance) replacing the older echelon maintenance concept. On the flight line, virtually nothing changed, because the functional organizational structure remained unaffected.

Establishment of the Air Force

A Standardized, Decentralized Maintenance Structure

Standardization of the wing and base organization under what was called the Hobson Plan was the Air Force's first action affecting maintenance.[9] The Hobson Plan replaced the World War II combined Combat and Service Group to provide unity of command and make the best use of what was a diminishing postwar personnel pool.[10] Four groups were established: the combat group, maintenance and supply group (M&S), airbase group, and medical group.[11] While organizational maintenance was placed in the combat group under the flying squadron commander, field maintenance was placed under the maintenance and supply group.

Because of greatly reduced flying requirements, top-heavy manning from experienced noncommissioned officers, and the relative simplicity of aircraft after World War II, the more traditional crew chief system was largely restored. These crew chiefs managed all work on an aircraft and supervised a team of mechanics in a classic, decentralized maintenance posture. The crew chief only occasionally had to request assistance from the field maintenance (third echelon) organization.

Berlin Airlift, Centralized Maintenance

Between June 1948 and September 1949, what became known as the Berlin Airlift was conducted. Maintenance for this airlift effort was organized as described in the Hobson Plan. Lieutenant General Curtis E. LeMay, commander of United States Air Forces in Europe (USAFE) at the time, determined that the crew chief system could not be adapted to work in the around-the-clock flying situation because of the limited number of hours a person was permitted to work. He decided that the only system capable of filling the requirements was the specialized, centralized maintenance system.

Thus, specialized aircraft maintenance was again employed, this time to support the Berlin Airlift.[12] Depot support was used extensively, and a central engine buildup line was operated at Rhein Main AB. Two 100-hour inspections were accomplished at Burtonwood Air Depot, and contractors in CONUS did 1,000-hour overhauls of C-54 aircraft.[13] The Berlin Airlift saw the first formation of a central production control at the Combined Airlift Task Force (CATF) Headquarters at Rhein Main. The central production control for airlift forces was established to monitor maintenance status, location, supply status, and other related maintenance data for all CATF aircraft. The consolidated control center scheduled all work for Burtonwood and CONUS with all lift bases.[14] An electronics squadron was formed, located in Berlin, to repair C-54 radio and radar components. The Berlin Airlift adapted the existing maintenance system, centralizing control, specialist maintenance centers, and extensive depot assistance. Another important adaptation was in the role of top-level command (leadership) in advocating or mandating major command (MAJCOM) or Air Force maintenance policy.

The 1950s, A Variety of Maintenance Organizations

LeMay became commander of the Strategic Air Command (SAC) in late 1949. Shortly after, SAC adopted a more specialized maintenance concept. SAC Regulation (SACR) 66-12, Maintenance Management, was written to "establish a functional aircraft maintenance organization within the wing/base organization, which would ensure full utilization of personnel and facilities to produce maximum availability of aircraft."[15] This required organizational change marked the first formal move toward centralized maintenance in the Air Force. The M&S group was disbanded, and three maintenance production squadrons were established: field maintenance, periodic maintenance, and electronic maintenance. The organizational maintenance capability was retained in the operational flying squadron in the combat group.[16] The main agency in this new structure was the wing maintenance control, which was responsible for the centralized direction and control of the wing's maintenance effort.

Other MAJCOMs were experimenting with different maintenance organizations during this period. Most retained the M&S group and were based on the crew chief's being supported by specialists where organizational maintenance was under the operational squadron commander.[17] The exception was Air Training Command (ATC), where the organizational maintenance squadron (OMS) was under the M&S group commander because of ATC's limited mobility requirements. In SAC and Tactical Air Command (TAC), when units deployed, they included specialists from the M&S group in order to be a self-sufficient deployed organization. The Military Air Transport Service (MATS) used a variation of specialized maintenance. All commands faced skilled personnel shortages.

In June 1950, the North Koreans invaded South Korea, and the United States again was involved in an armed conflict. The standard M&S system in place at the time—even SAC's version under SACR 66-12—was not suitable for meeting mission requirements, largely because of combat conditions and inadequate forward-based facilities from which to conduct maintenance operations. Consequently, a system of rear-echelon maintenance bases in Japan and Korea evolved. Combined with the rear units, these rear-echelon maintenance bases were known as rear echelon maintenance combined operations (REMCO).[18]

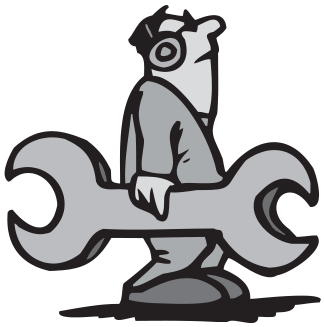
Crew chiefs at forward bases, with their crews, performed preflights, turnarounds, battle damage repair, preparation for a one-time flight to rear bases, and armament maintenance. Maintenance at these forward locations was limited to the quick-turnaround type of work aimed at keeping a maximum number of aircraft airworthy. The inability to achieve base self-sufficiency at forward locations made the REMCO adaptation necessary.

In 1953, ATC moved closer to centralized maintenance by forming periodic squadrons and placing all specialists in the field maintenance and armament sections. Also, planning and scheduling were moved to the chief of maintenance level, quality control was expanded, and dispatch of all specialists was accomplished by maintenance control.

About this time, Air Defense Command (ADC) was having considerable trouble maintaining the new F-86D aircraft with its airborne radar and integrated electronic fuel system control. To counter the problem, ADC relied on specialists' being given more extensive training and improved specialized technical orders and instructions. The result was reduced accident rates and higher aircraft availability for the F-86D.[19] This concept of breaking out aircraft systems into functional areas, with each area maintained by its own specialist, eventually was approved by the Air Staff and continually expanded as newer aircraft and significantly more complex systems were introduced into the inventory.

Also in 1953, the Air Force Inspector General (IG) began to question whether the montage of different maintenance concepts among MAJCOMs was serving the best interest of the Air Force. In a landmark semiannual report to the Chief of Staff, he pointed out:

> As a result of over one hundred (100) inspections, both readiness and technical, conducted by this office, it was determined that no universally effective specialized and standardized system of aircraft maintenance existed in the Air Force. The one notable exception is the Strategic Air Command, which has made a concerted effort to achieve a modern concept of maintenance and was experiencing excellent results in the conservation of skills, tools, facilities, and materials. Other commands, however, were employing various methods and systems of aircraft maintenance largely at the discretion of local commanders and maintenance officers.[20]



The increasing complexity of aircraft and the need for greater specialization saw more acceptance of centralized maintenance.

In December 1953, the Air Force published Air Force Regulation (AFR) 66-1, *Maintenance Engineering*. It was the first Air Force regulation dealing with maintenance management. Only four pages in length, it defined three levels of maintenance (organizational, field, and depot). It temporarily gave MAJCOMs authority to tailor maintenance organizations to suit their missions and types of aircraft. But it issued this caveat:

> Frequent reexamination of the Air Force maintenance structure will be made to ensure that organizations, facilities, equipment, and specialists are available and fully able to meet the support requirements of newly introduced items of equipment or weapon systems.[21]

In early 1955, the Air Staff initiated a study at Dover AFB, Delaware, a large MATS flying wing. Conducted by an Air Force management engineering team, the study proposed that organizational maintenance be removed from the operational flying squadron and consolidated with field maintenance under a wing chief of maintenance.[22] After 9 years as a service, the Air Force published definitive guidance on maintenance organizational structure on 1 September 1956. That guidance, in Air Force Manual (AFM) 66-1, *Maintenance Management*, was patterned after SACR 66-12 and incorporated the basic guidelines of AFR 66-1 and its revisions.

AFM 66-1, Centralized Maintenance

AFM 66-1 established a chief of maintenance responsible for all aircraft maintenance in the wing and reporting directly to the wing commander. The chief of maintenance was assisted by a staff to help in central control of all maintenance activity. Three squadrons worked directly for and reported to the chief of maintenance: the organization maintenance squadron, field maintenance squadron, and electronics maintenance squadron. The actual organizational structure was not new; it was a formalized version of existing structures. The manual set Air Force standards, goals, and objectives for maintenance, which included aircraft in-commission rates, component repair standards, and aircraft scheduling objectives, among many others. It also established the requirement for man-hour accounting and maintenance data collection, a major initiative.

When AFM 66-1 was first published, implementation was a MAJCOM option. It met with numerous objections and, other than in SAC, only perfunctory compliance.

Operational flying squadron commanders were leery of the "new and yet unproven system."[23] The centralized control aspect of AFM 66-1 meant to many that organizational maintenance would be taken out from under operations control. Centralized control of maintenance had the support of Air Force Chief of Staff General Thomas D. White, however, and in 1958, he made it mandatory for all Air Force organizations.[24]

As directed, all commands began to use AFM 66-1 in the 1960s. The increasing complexity of aircraft and the need for greater specialization saw more acceptance of centralized maintenance. Crew chiefs assigned to OMS worked on the flight line, assisted by other OMS (airplane general) resources. All other specialist personnel were assigned to either a field maintenance squadron or electronic maintenance squadron and later to armament and electronics squadrons and to munitions maintenance squadrons. These specialist personnel were located off the flight line and were dispatched to assist crew chiefs as necessary, requiring communications and coordination through job control (chief of maintenance staff personnel), which, in turn, required paperwork and documentation. This process involved high numbers of overhead persons, who were not directly involved in sortie generation on the flight line.[25]

Complex systems introduced with century series aircraft (particularly F-101, F-102, and F-106 aircraft) assigned to the Air Defense Command and similarly complex systems on SAC bombers drove the development of large numbers of specialists, particularly in avionics squadrons and, to a lesser extent, munitions maintenance squadrons. Systems aboard these modern fighter and bomber aircraft were so numerous and complex that technical schools generally required 52 weeks to complete technician training. Even then, further on-the-job and field training detachment training was required once the technician arrived at an assigned unit. Systems often failed, and repairs were lengthy. Only through specialist pools (mixtures of personnel with back-shop experience and personnel with on-equipment experience) could demands be met.

When new weapon systems were brought into the inventory, large cadres of technical representatives, many of them engineers, were provided by the prime and original equipment manufacturers. These technical representatives were used both for training and hands-on maintenance and had priority access to their firms' technical staffs.

Indeed, these factors, combined with others, produced high Air Force tactical fighter mission capable (MC) rates through the 1960s. The Air Force F-4 Phantom series aircraft was relatively new. Contractor technical representatives were embedded in maintenance organizations, and a large number of them were assigned across CONUS and Southeast Asia (SEA) units. Funding was readily available for SEA operations. The quality of both officer and enlisted training improved, and course durations increased. The senior workforce and management experience increased.

Vietnam Conflict, Decentralizing Trend

AFM 66-1 was practical for all MAJCOMs and gained general acceptance, but it was seriously tested, particularly in TAC, during the Vietnam era. Depending on existing manning levels, deployments may have made it difficult to cover specialist support requirements. Early deployments of smaller units (squadrons) to participate in the Vietnam conflict had austere manning, creating maintenance deficiencies and long hours of work. But temporary duty gave way to permanent change of station assignments, and squadrons often deployed with the same personnel assigned to them at home stations. The Air Force placed flight-line maintenance back into the tactical squadrons under operations. Personnel were identified with squadrons in CONUS so that peacetime work integrity would be maintained when deployed.

In the Pacific Air Forces (PACAF), PACAF Regulation 66-12 was issued. This regulation realigned the OMS maintenance officer administratively to the flying squadron but left him working for the chief of maintenance. The flying squadron commander thus rated OMS personnel even though they functionally worked for the chief of maintenance.

In 1966, TAC published TAC Manual (TACM) 66-31, instituting what was known as *TAC Enhancement*. Flight-line personnel moved from OMS into the tactical flying squadrons. Munitions load crews were likewise moved, phase was moved into the flying squadron from field maintenance squadron, and some specialist support was placed into the flying squadron for limited on-aircraft work, primarily removal and replacement of components.[26]

The new program was described in *TAC Attack* as an:

> …interim reorganization (which) will enhance the efficiency of maintenance functions within deployed and dispersed unit…from the moment they deploy. Continuity of supervision will not be interrupted. Squadrons will be better able to cope with the unavoidable problems of dislocations. Overall, decentralization will improve the capability of TAC's fight and reconnaissance squadrons to continue their worldwide mission.[27]

A little more than 1 year after LeMay retired as Chief of Staff, the tactical fighter community returned to decentralized maintenance.

The Early 1970s, Downsizing and Centralizing

Budgetary cuts accompanied the phasing down of military involvement in Southeast Asia. The duplication of resources resulting from TACM 66-31 no longer could be supported. By 1972, the number of Air Force members had dropped to its lowest since 1950, a 16-percent reduction just since 1966.[28]

Declines in MC rates for tactical fighters were related more to manpower reductions, skill-level reductions, introduction of complex new weapon systems (as with the F-111 series), increased problems with maintaining F-4 aircraft (now getting older), and spares reductions rather than to organizational structure. The move back to centralized maintenance became necessary to deal with the declining specialist availability and skill levels. The declining MC rates for these aircraft continued to grow despite the change back to the centralization that had earlier produced higher capability rates.

Studies done in USAFE showed that the F-4 aircraft could not be turned fully mission capable on a daily basis.[29] This was primarily because of the declining mean time between failure of F-4 systems and subsystems. Similar problems with the F-111 are also well-documented. There were enough F-4s to meet peacetime flying training requirements but not enough to generate the sortie surge requirements predicted under the War Mobilization Plan.

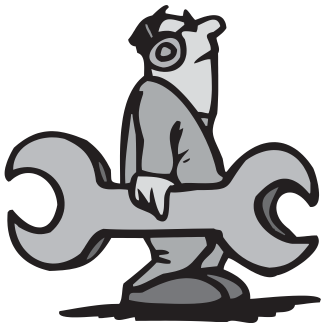
It could be argued that no form of organization would have made a difference in maintaining these complex and low-reliability weapon systems.

On 1 August 1972, the Air Force published a major revision to AFM 66-1 that greatly expanded maintenance guidance. The new manual consisted of ten volumes that covered every detail of Air Force maintenance, including that for aircraft, missiles, and communications equipment.

In the foreword of the new AFM 66-1, Chief of Staff General John D. Ryan said:

> Economy in the use of resources can only be achieved by balancing operational requirements and maintenance capability. This requires planning and comprehensive scheduling of equipment maintenance. Management effectiveness can then be measured in terms of maintenance accomplishments.[30]

The new manual emphasized "making equipment available for maintenance when the resources are available." Lieutenant Colonel Thomas E. Reiter noted in his Air War College thesis, "This was a significant philosophical change because, in the past, maintenance was performed whenever the aircraft were not on the flying schedule and the new policy basically called for the aircraft to be on the flying schedule whenever they were not required to be in maintenance."[31] This marked the first time such definitive guidance had been given from such a high level. Ryan's comments on balancing requirements in operations and maintenance and his measures of merit do not imply an organizational structure.



POMO was designed from lessons learned from the Israeli Air Force during the 1973 Arab-Israeli war (Yom Kippur).

The strict adherence to a rigid program of reporting and documenting maintenance actions, the establishment of MAJCOM evaluation teams to ensure compliance, and rigorous IG inspections and operational readiness inspections seemed to provide a clear message that the years of flexibility in the area of maintenance organizational structure were over. This standard manual and its organization were the final authority and discouraged further innovation.

In USAFE, from 1971 to 1974, General David C. Jones, Commander in Chief, USAFE, set several initiatives in motion that would have a broad impact on maintenance organization in the future. Jones became concerned with more effective use of USAFE resources.[32] USAFE's Project Streamline evaluated extensive initiatives, including cross-utilization training of maintenance personnel. A separate initiative, briefed to Jones prior to his reassignment as Air Force Chief of Staff, dealt with centralizing maintenance even further and called for centralized intermediate repair facilities (CIRF) to support forward base operations in wartime to reduce airlift requirements and the logistics footprint.

USAFE Vice Commander Lieutenant General Louis Wilson was reassigned to PACAF to take over as PACAF Commander in Chief. He asked for a staff paper that he would use to implement the CIRF concept at Kadena AB. Jones, then Chief of Staff, established the Maintenance Posture Improvement Program (MPIP) in 1976 to "find new ways of going about the complicated business of maintenance, which would permit more efficient and effective use of the total Air Force maintenance resources."[33] The CIRF project studies were included as part of the MPIP. The proposal in USAFE and the CIRF activities within PACAF to centralize intermediate maintenance became widely known. While there was basic Chief of Staff agreement to continue to pursue the feasibility of the proposed centralization where applicable, the proposal met with significant opposition among proponents of base self-sufficiency, particularly within TAC.

To respond to MPIP and, likewise, respond to USAFE and PACAF centralized maintenance initiatives, TAC proposed and tested a new base-level maintenance organization called the Production Oriented Maintenance Organization (POMO).

The Mid-1970s, POMO and Decentralized Execution with Central Control

POMO was designed from lessons learned from the Israeli Air Force during the 1973 Arab-Israeli war (Yom Kippur). The Israeli Air Force was able to generate high sortie rates by cross-utilizing skills of personnel and assigning them to a flight-line organization where they were directly responsible for repairing, servicing, and launching aircraft. People not directly contributing to generating aircraft were assigned to back shops. A TAC team sent to Israel said the Israeli system of maintenance

"appeared to have great possibilities in the fighter environment," where "rapid aircraft turnaround, sortie generation, and surge capability were essential."[34] Under POMO, specialists from the electronic maintenance squadron, field maintenance squadron, and munitions maintenance squadron were assigned directly to the flight line and placed in the same squadron as aircraft generalist crew chiefs or airframe and powerplant generalists.

The resulting squadron was named the aircraft generation squadron instead of OMS because it was now able to handle all on-equipment maintenance. The aircraft generation squadron consisted of aircraft maintenance units, which were aligned respectively with flying squadrons. In some cases, weapons load crews also were assigned to an aircraft generation squadron as weapons maintenance units. The remaining specialists were grouped in two new squadrons—the equipment maintenance squadron and the component repair squadron—and performed all off-equipment maintenance. The POMO often is described as decentralized execution with centralized control because the chief of maintenance and his staff remained the same and maintenance and job control continued to control the entire maintenance effort.

During this same time, the F-111 ushered in a new flight-line remove-and-replace (2R) era of maintenance, which meant fewer specialists were required for on-equipment maintenance. This move to 2R maintenance also resulted in less detailed technical training for many specialists. Now aircraft began to incorporate self-test/built-in-test features that eliminated the more detailed on-equipment troubleshooting seen in the past. With the introduction of avionics intermediate shops and modular engine components, on-equipment maintenance became less specialized.

Upon implementation, the POMO structure did not increase sortie production as expected. One comprehensive study found that POMO "has had little, if any, positive effect on aircraft maintenance in a peacetime operating environment."[35] The study found strong indications that POMO had caused some degradation in aircraft maintenance performance. It stated in its discussion of implications for management that "if the Air Force wants increased productivity, then one or all of the components of maintenance efficiency must be improved" and that "organizational efficiency has in many cases only a limited impact on the overall efficiency of a maintenance action when compared to what is embodied in the sequence of tasks required in the maintenance action itself."[36]

The Late 1970s and 1980s, Increased Decentralized Execution, Less Centralized Control

When General Wilbur L. Creech took command of TAC in 1978, he ordered his own study. It found that sortie production had fallen 7.8 percent from 1969 to 1978 and concluded that this decline was attributable not to external factors but simply to maintenance's inability to produce the required sorties.[37] The new TAC Commander felt the organization of maintenance was a major factor in this decline and led TAC to create the Combat Oriented Maintenance Organization (COMO), formalized under TAC Regulation (TACR) 66-5.

TACR 66-5 differed from POMO in many ways. Each squadron aircraft maintenance unit now performed its own scheduling and was responsible for its own utilization rate. Each squadron aircraft maintenance unit had its own dedicated analyst. Supply was decentralized to each aircraft maintenance unit, and the wing-level maintenance supply liaison was eliminated. Each squadron aircraft maintenance unit performed its own debriefing, had its own pool of aerospace ground equipment, and dispatched its own flight-line personnel to jobs. And a dedicated crew chief was assigned to each aircraft. The deputy commander for maintenance (DCM) remained responsible for all maintenance and reported to the wing commander. Maintenance control now *coordinated* maintenance activities more than it *controlled* maintenance. COMO also proved to be very manpower intensive.

The MC rates for tactical fighters continued to increase. One report declared:

> The results of the transition to COMO have been dramatic. Sortie production, from the third quarter of 1978 to 1983, rose at an annual rate of 11.2 percent. In the first full year under COMO, 1979, TAC flew all its programmed sorties for the first time in a decade.[38]

In 1990, the MC rates increased to an all-time high of 88.4 percent. When considering the increased sortie rates reported by TAC between 1978 and 1983 and beyond, however, consideration needs to be given to the fact that the period also saw a changeover to more modern and more reliable tactical aircraft, better technical data through the introduction of job procedural aids and guides, better automatic test equipment, and more accessibility and better maintainability because of technology advances and lessons learned from F-4 and F-111 problems. All could have had an impact on the increased MC rates.

Interviews with senior maintenance officers indicated that the senior management workforce during the changes to COMO had considerable experience and careful career management. The rated supplement (to maintenance) and the maintenance officer career fields both had specialized career management through the Military Personnel Center. The rated supplement had its own branch, and Palace Log was established within the Officer Management Division, both carefully managing individual careers and tracking high performers and assisting them to grow into commander's jobs and DCMs. Palace Log often took in first assignment instructor pilots who had finished their tour teaching new pilots and could find no open cockpit slots. They were then placed in maintenance and became advocates of maintenance as they progressed through their rated careers.

In addition, there was consensus among the senior maintenance managers interviewed that, during COMO, there was a highly trained professional maintenance workforce backed up by senior technicians who had considerable skill in the older mission design series that would soon be replaced by newer, more reliable, and easier-to-maintain tactical aircraft. These professional maintainers saw COMO as more effective than–but perhaps not as efficient as–the previous, centralized maintenance. It is also important to understand that the transition from POMO to COMO was not a major reorganization but, instead, a realignment of responsibilities and functions.

The Early 1990s, MAJCOM-Specific Maintenance Organizations

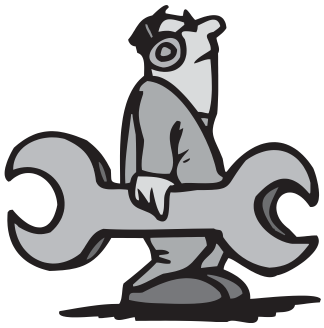
MAJCOMs in 1990 were operating mostly in modes acceptable to each while still pursuing optimal maintenance concepts more

suited to ever-changing operational requirements. Tactical air force MAJCOMs finally had adapted COMO to their requirements. SAC formally implemented a decentralized structure in 1987, the implementing directive being SAC Regulation 66-14, *Readiness-Oriented Logistics System (ROLS) Maintenance Management General Policy, and Deputy Commander for Maintenance (DCM) Staff Activities*. ROLS was similar to COMO and obviously influenced by it, but AFM 66-1 was still visible.[39] The Military Airlift Command (MAC), the most consistent of the MAJCOMs in terms of maintenance organizational structure, remained committed to centralized maintenance; its implementing directive was MAC Regulation 66-1, *Maintenance Management Policy*.[40]

During Desert Shield and Desert Storm:

> …maintenance organizations were to be aligned under AFM 66-1 procedures..... The CENTAF/LGM was a staff advisor to deployed wings. Each base installation having more than one wing would have a lead unit DCM who would then appoint senior tenant wing maintenance officers as assistant DCMs. Collocated units were to be prepared to form joint maintenance operations centers (JMOCs) and job control (JC) units.[41]

In fact, each MAJCOM maintained aircraft in accordance with its peacetime organizations.



The organizational aspects of the transition to the EAF resulted in the designation of ten air and space expeditionary forces that rotate their availability for deployment and rapid response on a periodic basis.

The one notable difference from tactical fighter support in peacetime was the establishment of CIRFs out of theater (in USAFE or at home bases) for avionics (except electronic countermeasure pods) and engine maintenance.[42] In part, the acceptance of centralized intermediate maintenance was driven by a compromise between the need to limit population in the area of responsibility and the desire for self-sufficiency. There was concern that lines of communication would be interrupted if intermediate maintenance were out of the area of responsibility, but this concern gave way, in part, to the limited number of people the theater could support.[42]

One other major maintenance variation occurred with the establishment of the 7440th Composite Wing (Proven Force) consisting of ten different mission design series aircraft. The wing established seven aircraft maintenance units (one for each flying squadron), a combined component maintenance and equipment maintenance section, and an ammunition branch out of the 39th Consolidated Aircraft Maintenance Squadron and deployed USAFE units. The official history of Proven Force states that monitoring of the parts flow was highly effective but also was cumbersome and manpower-intensive, requiring manual tracing of as many as 500 pieces of cargo each day. Proven Force MC rates were approximately the same as those for peacetime and similar models of aircraft.[45]

The Mid- and Late-1990s, Objective Wing Decentralized Structure

When General Merrill McPeak ordered the change to the objective wing, he was issuing a major change to the combat air force (CAF), although the objective wing was an effort to standardize organizations across all commands in the Air Force. This standardization effort, which applied to all Air Force wings, was based on McPeak's description as "one base, one wing, one commander."[46] It was intended (again) that Air Force wings should train as they fight. It accomplished this by having a single wing commander at each base, with flight crews and flight-line maintenance personnel working for the flying squadron commander, who reports to the operations group commander. The back-shop maintenance, supply, and transportation personnel would work for a logistics group commander.

Some variations were made to this basic objective wing structure in 1992 when a deputy for operations group maintenance was created to provide overall supervision for all flying squadron maintenance, the phase docks, and interface with the logistics group commander to resolve issues with back-shop or other supply and transportation support of sortie generation and phase activities. Maintenance control had become the maintenance operations center under the wing. Quality assurance was also under the wing. The net result for CAF units was to return them more closely to traditional squadron maintenance. The logistics interface with organizational-level maintenance (sortie generation) was minimal except through interface with the operations group, and in some instances, a maintainer did not fill the logistics commander billet.

Several MAJCOMs had objective wing variations approved, permitting them to keep all maintenance responsibilities under the logistics group commander. These were Air Mobility Command (AMC), ATC, Air Force Special Operations Command, the Air National Guard, and the Air Force Reserve Command.

Two other major changes took place in the 1990s that would not impact the objective wing structure directly but would introduce new considerations to the conduct of maintenance on a broader scale. The first was the formation of the Air Combat Command on 1 June 1992. The distinctions between tactical and strategic aircraft were blurred by operations in Vietnam (bombers doing tactical missions). During Desert Storm, the Secretary of the Air Force, Chief of Staff, Vice Chief, and TAC and SAC commanders all spearheaded the drive to integrate the assets of SAC and TAC into a single operational command. At the same time, MAC reorganized by consolidating airlift and most refueling assets under a single umbrella, the new AMC. AMC provided the *global reach* facet of the Air Force mission, while the new ACC provided the Air Force's *global power*.[47]

The second change was the formation of the expeditionary air force (EAF) in response to both an evolving world situation with popup contingencies in places where the Air Force had rarely operated before and continuing steady-state regional security commitments far from any Air Force main operating base. The organizational aspects of the transition to the EAF resulted in the designation of ten air and space expeditionary forces (AEF) that rotate their availability for deployment and rapid response on a periodic basis. This required the establishment of a global system of CONUS support locations, forward support locations, and forward operating locations (FOL), all of which have affected maintenance operations in that units at FOLs are supported much the same way as squadrons at forward bases were supported during the Gulf War.[48] The relatively autonomous CAF flying squadron under the objective wing was seen as conducive to EAF and AEF operations.

In February 2002, General John Jumper, Chief of Staff of the Air Force, put together a working group to examine a standardized wing organizational structure. The purpose of the working group was to present a new wing and group organizational structure designed to meet the needs of the AEF. Jumper, as well as other Air Force senior leaders, had determined that an organizational restructure was needed to improve combat readiness and enable the Air Force to focus on its core disciplines.[49]

On 25 March 2002, Jumper and the MAJCOMs approved the new combat wing organization structure. On 22 April 2002, Jumper sent out a message via the Defense Messaging System informing Air Force personnel of this new, standardized wing structure.

The new wing structure consists of four groups: the operations group, maintenance group, mission support group, and medical group (Figure 1). Their responsibilities are as follows:

- **Operations Group.** Operations group activities will focus on planning and executing air and space power.
- **Maintenance Group.** Aging fleets and years of resource shortfalls require increased attention to the balance of sortie production and health of our fleet.
- **Mission Support Group.** The Air Force will develop a career path for commanders who understand the full scope of home-station employment and sustainment and deployment, beddown, and sustainment at contingency locations: crisis actions, force protection, unit type code preparation, load planning, communications, en route visibility, reception, contracting actions, bare base and tent city preparation, munitions site planning, personnel readiness, expeditionary combat support, and so on.
- **Medical Group.** Medical groups will continue to focus on maintaining a fit and ready force.[50]

Conclusions

Throughout its history, the Air Force has moved between centralized and decentralized, standardized and MAJCOM-varied maintenance organizations, often in response to changes in budgets, resources, and technology. Transformation is likely to continue, and organizations will likely continue to evolve to support changing mission requirements within current resource constraints.

Notes

1. *Air Service Plan of Supply, Salvage, and Repair*, Memorandum No 37, Aug 18.
2. Royal D. Frey, "Evolution of Maintenance Engineering," Vol 1, unpublished historical study, AMC, Wright-Patterson AFB, Ohio, Jul 60.
3. Army Air Forces, War Department Circular 65-11, *The Air Corps System of Maintenance,* Washington DC, 5 Apr 29.
4. Capt James N. Townsend, "A History of Aircraft Maintenance in the Army Air Forces and United States Air Force," Research Report, Air Command and Staff College, Maxwell AFB, Alabama, 78, 19.
5. Townsend, 20.
6. Townsend, 21.
7. *Production Line Maintenance Manuals*, Patterson Field, Ohio, Headquarters, Army Air Forces, 15 Feb 44.
8. Ernest W. Spitzer, Readings and Seminar, Command and Management, Vol 5, "Maintenance in the US Air Force," Air Command and Staff College, Maxwell AFB, Alabama, Dec 77, 328.
9. Townsend, 27.
10. Lt Col Thomas E. Reiter, "USAF Aircraft Maintenance Organizational Structure: Where We've Been, Where We Are, What's the Future," Research Report, Air War College, Air University, Maxwell AFB, Alabama, Apr 88, 5.
11. Col Edmund J. Borowski, "The Suitability of the USAF Aircraft Maintenance System for Total War," Air War College, Air University, Maxwell AFB, Alabama, 1952, 49.
12. Col Richard J. Fry, "Aircraft Maintenance, A Limiting Factor in the Strategic Air Command," Air War College, Maxwell AFB, Alabama, 1957, 7.
13. "Berlin Airlift, A USAFE Summary, 26 Jun 48—20 Sep 49," unpublished resume of Berlin Airlift, USAFE, 16–17.
14. *Ibid.*
15. Townsend, 28.
16. Borowski, 51.
17. Townsend, 32.
18. Carl G. Nelson, "REMCO: A Korean War Development, Air War in Korea," Vol VIII, *Air University Quarterly Review*, Vol VI, No 2, Summer 1953, 78–85.
19. Townsend, 35.
20. Fry, 9.
21. Air Force Regulation 66-1, *Maintenance Engineering*, Department of the Air Force, Washington DC, 30 Dec 53, 1.
22. Capt George D. Benjamin, "An Analysis of Aircraft Maintenance Management within Air Weather Service", Research Study, Air Command and Staff College, Air University, Maxwell AFB, Alabama, 1965, 11.

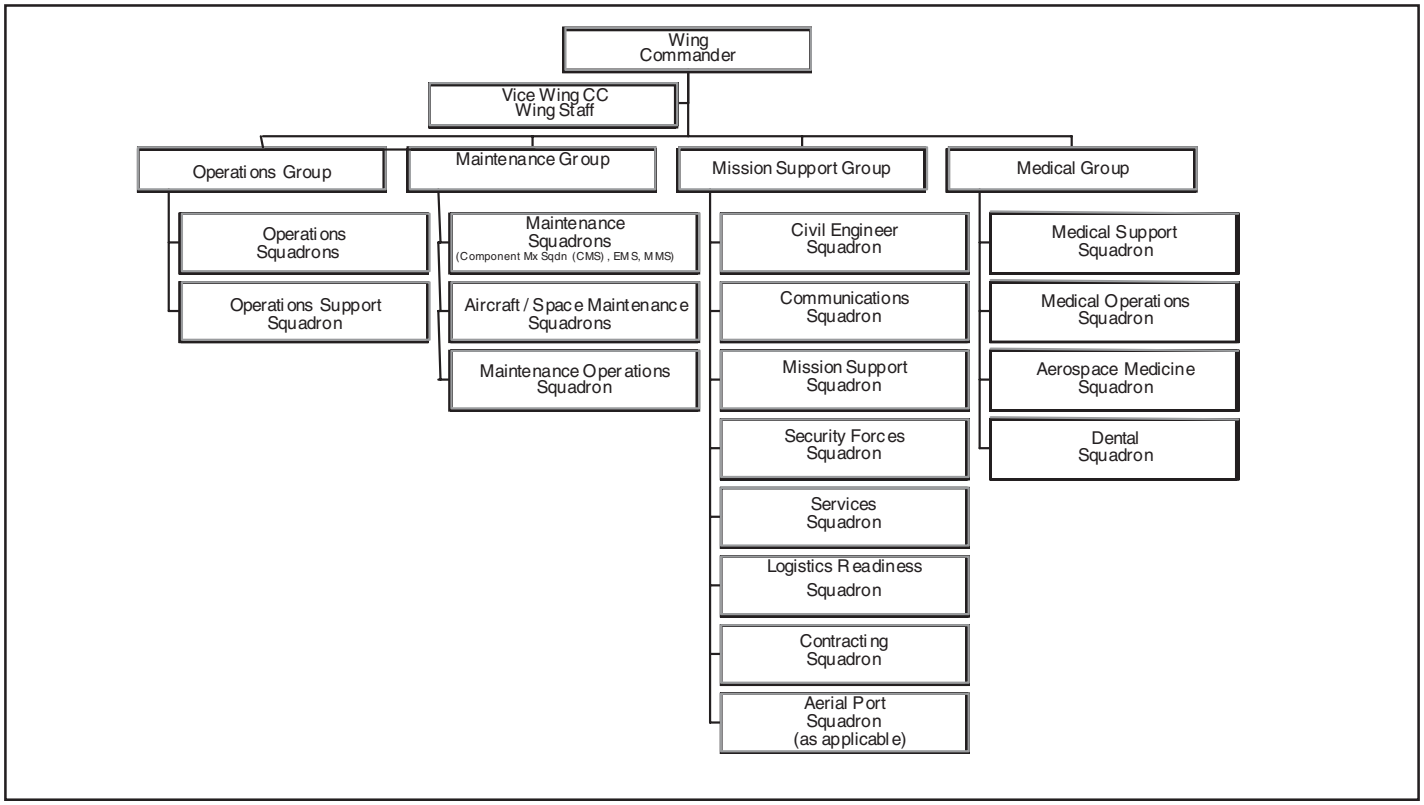


Figure 1. Combat Wing Organization[50]

23. Lt Col Thomas P. Foss, *The Logistics of Waging War*, Air Force Gunter AFS: Alabama, Air Force Logistics Management Center, 1983, 151.
24. Benjamin, 12.
25. Capt Wesley C. Davis and Capt Sanford Walker, "A Comparison of Aircraft Maintenance Organizational Structures," master's thesis, AFIT/GLM/LSM/925-16, School of Systems and Logistics, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio, Sep 92, 126.
26. US Air Force, Tactical Air Command Manual 66-31, Maintenance Management, Headquarters, Tactical Air Command, Langley AFB, Virginia, Aug 66.
27. Ronad G. Slaunwhite, "Squadron Maintenance," *TAC Attack*, Aug 66, 13.
28. "USAF Personnel Strength—1907 Through 1968," *Air Force Magazine*, May 87, 79.
29. Maj Logan J. Bennett, 3.0: A Look at Constraints on Achieving Three Turns (Daily) Using F-4 Aircraft, Briefing for CINCUSAFE, DCS/Logistics, 1974.
30. US Air Force, AFM 66-1, "Chief of Maintenance (Aircraft and Missile)," *Maintenance Management*, Vol 2, Washington DC, 1 Aug 73, Foreword.
31. Reiter, 18.
32. Project Streamline, HQ USAFE, DCS/Logistics, Directorate of Maintenance, Nov 73.
33. Maj Gen William R. Nelson, "POMO—A New Concept," *Aerospace Safety*, Mar 77, 3.
34. Maj Norman J. Beu and Maj Richard C. Nichols, "More Maintenance in OMS," Research Study, Air Command and Staff College, Air University, Maxwell AFB, Alabama, May 77, 78.
35. Capt Dwight J. Foster and Capt John C. Olsen, "A Comparative Evaluation of the Effects of the Implementation of the Production Oriented Maintenance Organization (POMO) on Aircraft Maintenance," master's thesis, LSSR 27-785, School of Systems and Logistics, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio Sep 78.
36. Foster, et al, 110.
37. Capt Barbara L. Harris, "Challenges to United States Tactical Air Force Aircraft Maintenance Personnel," master's thesis, AFIT/GLM/LSM/915-28, School of Systems and Logistics, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio, Sep 91, 19–20.
38. Harris, 150.
39. Reiter, 30.
40. Reiter, 26.
41. Dr Eliot Cohen, *Gulf Air War Power Survey*, Vol III, Logistics and Support, Department of the Air Force, DS79.724.U6G95, 1993, 61.
42. Cohen, 308.
43. Cohen, 311.
44. Cohen, 332.
45. Capt Wesley C. Davis and Capt Sanford Walker, " A Comparison of Aircraft Maintenance Organizational Structures," master's thesis, (AFIT/GLM/LSM/925-16) School of Systems and Logistics, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio, Sep 92, 21 and 126.
46. "Air Combat Command History," 2002 [Online] Available: http://www2.acc.af.mil/library/history.
47. Paul S. Killingsworth, et al, "Flexbasing: Achieving Global Presence for Expeditionary Aerospace Forces," MR-1113-AF, RAND Corporation, 2002, xvii.
48. Air Force Working Group, "New Air Force Wing/Group Organizational Structure," working group paper, Feb 02.
49. Gen John Jumper, Chief of Staff Message transmitted via Defense Messaging System, 22 Apr 02.
50. "New Air Force Wing/Group Organizational Structure."

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notable quotes

Army officers are intelligen—give them the bare tree, let them supply the leaves.

—General George C. Marshall

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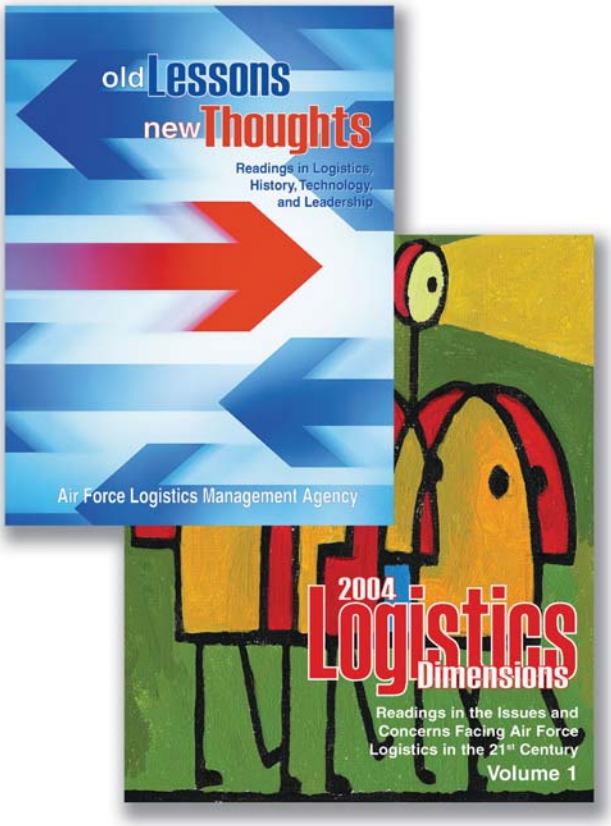

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